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AN UPDATED CHECKLIST OF SPIDERS FROM MALAYSIA WITH NOTES ON SPIDERS (ARACHNID: ARANEAE) FROM PUSAT PENYELIDIKAN PERTANIAN TUN RAZAK, PAHANG

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ABSTRACT

Recent findings and changes in nomenclature or groups warrant an update to the checklist of spiders in Malaysia. Documentation of spiders in agricultural areas of Malaysia is also limited. Hence, this study aims to update the checklist of spiders in Malaysia based on recent information and provide further documentation on the diversity and composition of arachnid families found in the agricultural ecosystem. Based on literature published from 1841 to 2023, the current checklist of spiders from Malaysia includes 1,162 species across 57 families and 438 genera. The families Salticidae, Araneidae, and Pholcidae are the most species-rich. The araneofauna in Sabah and Sarawak in the Borneo is the richest, with 420 and 355 species respectively, followed by states in Peninsular Malaysia: Pahang (210 species), Selangor (177 species), and Penang (178 species). Spiders have been collected at 236 localities, and the results have been published in 262 papers. A total of 1,188 individuals from 11 families and 34 genera have been collected from different types of habitats in Pusat Penyelidikan Pertanian Tun Razak (PPPTR). *Leucauge decorata* was recorded for the first time in Pahang. Future research should prioritise systematic inventories in Malaysian ecosystems, supported by comprehensive taxonomic and ecological studies to enhance understanding of their diversity and distribution.

Introduction

Spiders (Arachnida: Araneae) encompass a diverse group of terrestrial arthropods with a rich taxonomic history, ranking seventh in total species diversity among all other groups of organisms (Cardoso & Morano, 2010; Campuzano *et al*., 2019). To date, approximately 52,654 documented spider species belong to more than 4,510 genera and 138 families distributed worldwide (World Spider Catalogue, 2026).

As one of the most dominant arthropod predators in ecosystems, spiders exhibit a remarkable array of predatory strategies that contribute to their effectiveness as natural pest controllers (Nyffeler *et al*., 2017), providing important ecosystem services, including but not limited to biological control agents (Michalko *et al*., 2019), bioindicators (Cardoso *et al*., 2010), and significant natural decomposers (De Jong *et*

al., 2021). Overall, spiders play crucial roles in maintaining ecosystem dynamics, influencing both trophic interactions and nutrient cycling processes.

Despite their wide distribution and substantial ecological significance, published documentation of spider diversity in tropical regions is limited. Nearly 80% of spider species in tropical areas have not been described (Deeleman-Reinhold, 2001). This documentation is especially scarce for Malaysia, despite being a mega-diverse country (Dzulhelmi *et al*., 2016). A decade ago, Norma-Rashid and Li (2009) compiled the first checklist of spiders from Peninsular Malaysia. Following this, more spider species were recorded from Peninsular Malaysia (Dzulhelmi *et al*., 2014), Sarawak (Dzulhelmi *et al*., 2016a), and Sabah (Dzulhelmi *et al*., 2016b). Recently, a compilation estimated the number of recorded spider species in Malaysia to reach up to 1,040 (Nik Ahmad Irwan *et al*., 2023).

These inventories provide baseline information on spider diversity and distribution in some habitats, but other major habitats and agricultural ecosystems in Malaysia have been neglected. Over the years, there have also been new findings and changes in nomenclature, making it necessary to revise and re-examine the existing checklist, updating the total list to include both Malaysian regions. The scarcity of recent and comprehensive records has hindered our ability to appreciate the true extent of arachnid biodiversity in the region and has posed challenges to stakeholders in developing effective biodiversity conservation and management strategies.

Agricultural landscapes are among the habitats where a diverse range of spiders can be found (Michalko *et al*., 2019). Spiders play an important role as predatory arthropods, contributing to an ecosystem service of significant interest in agroecosystems, particularly in pest control (Plath *et al*., 2021). However, little is known about spiders within the agricultural landscape of Malaysia. The Pusat Penyelidikan Pertanian Tun Razak (PPPTR) in Pahang is a plantation-tourism area that cultivates a wide range of mainstream crops, from oil palm, rubber, and cocoa to coconut and various fruits. The spider fauna in this agroecosystem is poorly documented compared to other arthropod species (Nadiah *et al*., 2016; Ahmad Bukhary *et al*., 2019). The PPPTR serves as a suitable model site to study spiders in the agricultural areas of Malaysia.

Hence, the objective of this study is to update the checklist of spiders in Malaysia based on the latest information on spider distribution in the country and to provide further documentation on the diversity and composition of arachnid families found in Malaysian agricultural areas, with PPPTR, Pahang, as a model site. The information obtained will contribute to the growing body of knowledge about spider diversity in Malaysia, emphasising the importance of updated checklists in understanding and conserving this vital organism.

Materials and Methods

Secondary Information Survey

Malaysia is a federal constitutional country divided by the South China Sea into two regions: Peninsular Malaysia (West Malaysia) and Borneo's East Malaysia. A comprehensive literature review was conducted by accessing the repositories of the Malaysia Biodiversity Information System (MyBIS, 2024), the World Spider Catalog (2024) and the Google Scholar database. All peer-reviewed articles on spider diversity, taxonomy, and checklists in Malaysia from 1841 to 2023 were collated and reviewed. The geographical distribution of each spider species has been recorded in detail. The investigation covered administrative states (Johor, Melaka, Negeri Sembilan, Selangor, Pahang, Terengganu, Kelantan, Perak, Penang, Kedah, Perlis, Sabah and Sarawak) and two federal territories (Kuala Lumpur and Labuan). The species checklist is organised

as a table, which provides records from each state and references to the summary surveys. Species are listed alphabetically by family and then by genera within the families, with the nomenclature following the World Spider Catalogue (2024). The checklist consists only of species with complete scientific names. If a species was recorded under another name, this name is written in parentheses after the author's name as a synonym in the case of erroneous identification.

Study Area

Spider samples were collected during a field survey conducted in an agroecosystem located at Pusat Penyelidikan Pertanian Tun Razak (PPPTR), Tekam, Pahang, Malaysia (3°53'02.3" N, 102°31'53.1" E; Figure 1). PPPTR covers a total area of 2,379 hectares, featuring a heterogeneous landscape that includes 1,627 hectares of oil palm plantation, 227 hectares of multi-crop plantations, as well as other land areas comprising recreational and residential zones, and a forest buffer strip (Figure 2).

Sampling and Identification

The field sampling was conducted over three consecutive days from 15 to 17 March 2023. Active searches were carried out for a total of nine hours per day in three sessions: 0900 to 1200 hours, 1400 to 1700 hours, and 2000 to 2300 hours. A total of six collectors took turns actively searching for spiders in one-hour intervals for each sampling session. The collection methods for spiders were adapted from Malumbres-Olarte *et al.* (2017), employing hand-picking and sweep netting. The search for spiders took place in various microhabitats, including trees, branches, tree trunks, leaf litter, logs, and rocks. All live spiders collected were kept in closed containers and transported to the laboratory for identification. Samples were identified to the lowest possible taxon using references from Song *et al.* (1999), Murphy and Murphy (2000), Koh and Ming (2013), Dzulhelmi and Suriyanti (2015), Nik Ahmad Irwan *et al.* (2023), and various taxonomic literature from the World Spider Catalog (2024). All samples were deposited in the Faculty of Applied Science, UiTM Pahang, Jengka Campus.

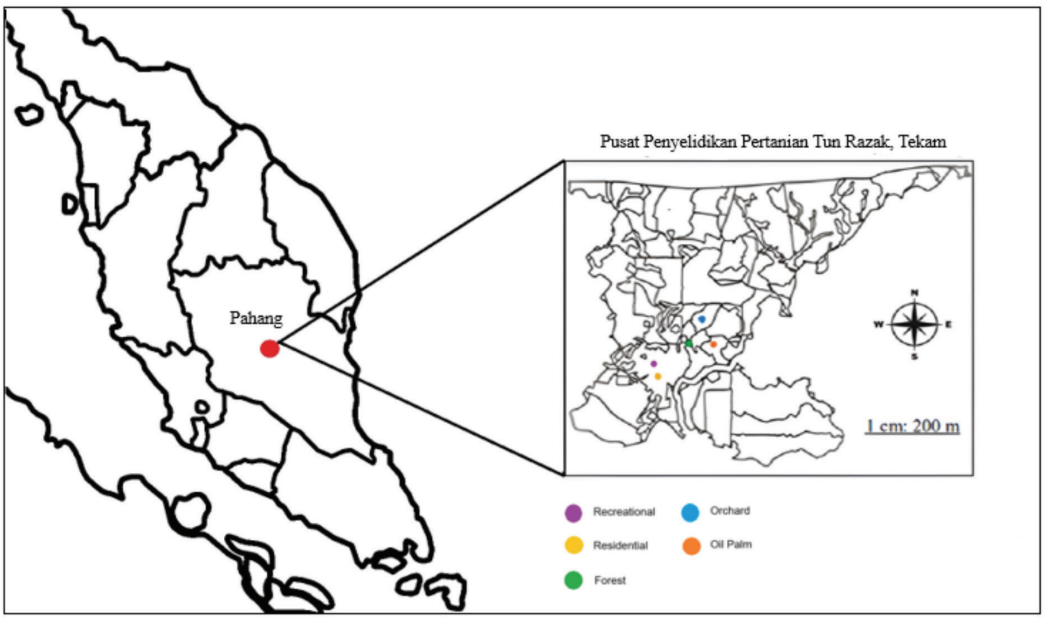


Figure 1: Location of the sampling site, Pusat Penyelidikan Pertanian Tun Razak (PPPTR), in Tekam, Pahang, Peninsular Malaysia

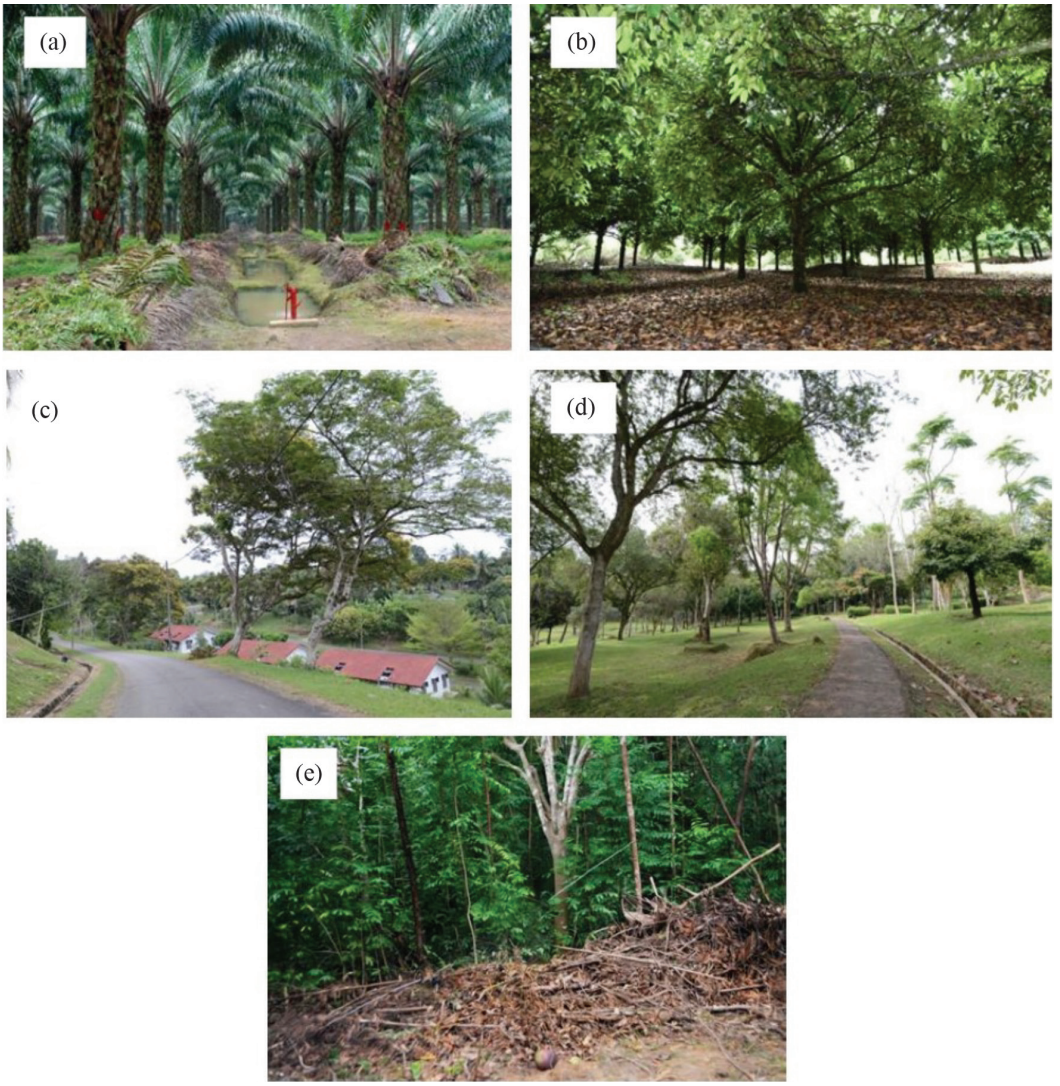


Figure 2: The heterogeneous landscape in the PPPTR agroecosystem in Pahang, featuring (a) oil palm plantation, (b) orchard, (c) residential area, (d) recreational area, and (e) forest buffer

Data Analyses

Spider taxonomic diversity was expressed using the Shannon diversity index (H'). Cluster analysis was conducted to identify similarities in spider composition across different habitat types in the PPPTR agroecosystem. A Chi-squared test of independence was performed to assess significant differences in guild composition between each habitat type. Spiders were grouped into four major guilds based on hunting strategies and web-building types: a) aerial web builders (Tetragnathidae, Linyphiidae, Theridiidae, Uloboridae, Araneidae), b) sheet web builders (Agelenidae), c) ambushers/ stalkers (Oxyopidae, Salticidae, Thomisidae), and d) running hunters (Sparassidae, Lycosidae), following Uetz (1999). All statistical analyses were conducted using PAST 4.03.

Results

Updated Checklist of Spiders in Malaysia

A total of 1,162 species of spiders from 57 families and 438 genera found in Malaysia have been reported in published literature from 1841 to 2023 (Appendix 1; Table 1). Our recent findings in the PPPTR agroecosystem in Pahang are also included in this checklist. While 26 species were recorded without a specific locality in Malaysia, a total of 194 species (16.62%) are widely distributed across the country, being found in both Peninsular Malaysia and Borneo. In contrast, 483 species (41.57%) were recorded only in Peninsular Malaysia, whereas 455 species (39.16%) were recorded only in Borneo. In Peninsular Malaysia, most spider species were recorded in the states of Pahang (210 species), Selangor (177 species), Penang (178 species), Perak (61 species), and Johor (55 species). The states of Perlis, Melaka, and Terengganu recorded fewer than 15 species of spider each. There are 121 species of spiders recorded without any specific locality within the Peninsular. In Borneo, more spider species were recorded in Sabah (420 species) compared to Sarawak (355 species). The number of species recorded in each administrative state is represented as a map in Figure 3.

Salticids remain dominant in terms of richness, with 282 species, accounting for 24% of the total number of species found in Malaysia. This is followed by Araneidae with 116 species (10%) and Pholcidae with 68 species (6%). The most speciose genera are *Malinella* (48 species), *Bowie* (27 species), *Myrmarachne* (25 species), *Heteropoda* (22 species), *Clubiona (13 species),Liphisitius* (19 species), and *Gastheracantha* (13 species). Five species, namely *Araneus nox, Argiope anasuja, Poltys elevatus, Pribumia atrigularis*, and *Pseudocnemis brachyramosa*, were new to Peninsular Malaysia in 2023. The newest species recorded in Borneo in 2023 are *Utivarachna ittokai, Lokina kubah, Lokina blombergi*, and

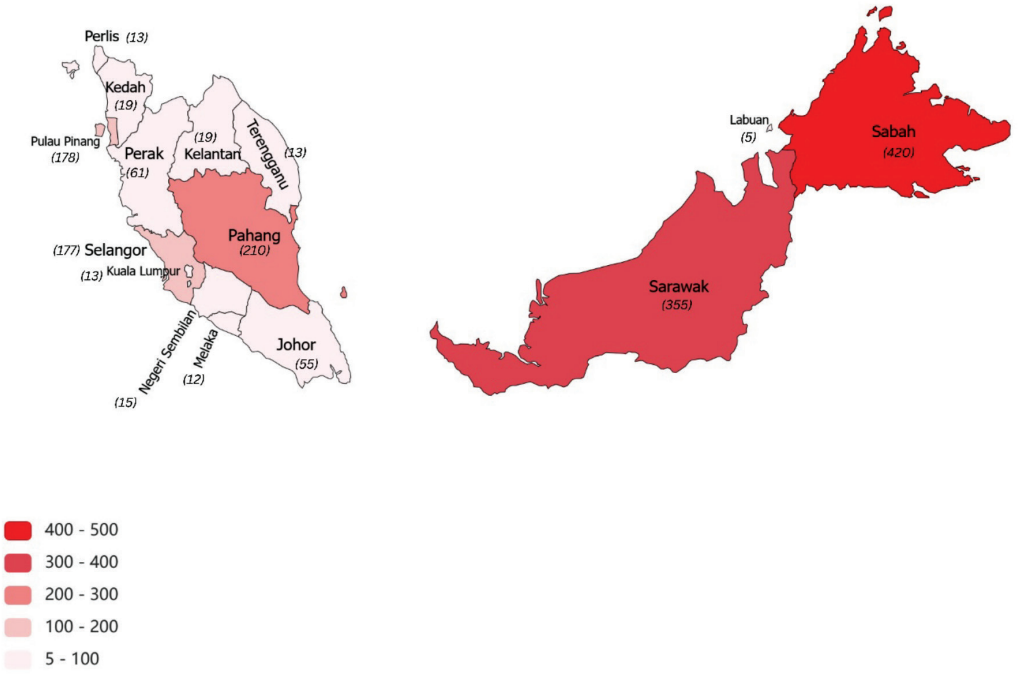
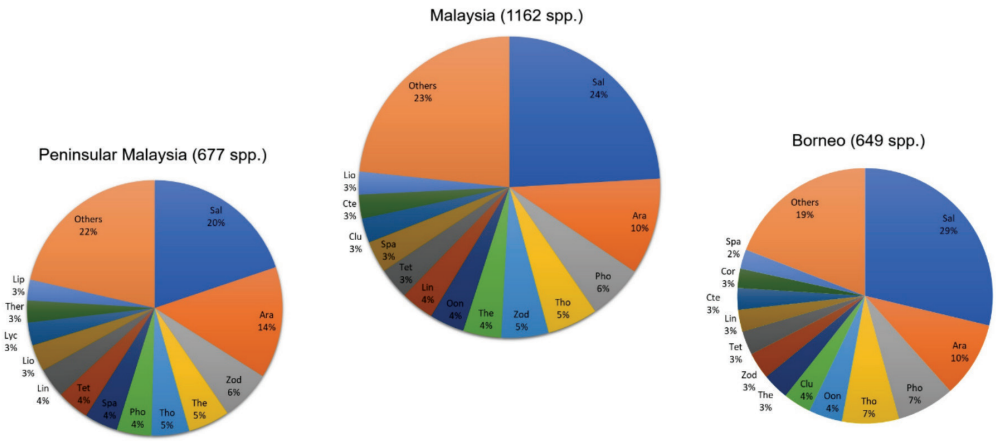


Figure 3: Administrative divisions of Malaysia and the number of species recorded in each state

Lokina pixi, found in Sarawak. Peninsular Malaysia recorded a higher species richness with 677 species compared to Borneo with 649 species (Figure 4). The Salticidae are dominant in both Peninsular Malaysia (135 species, 28%) and Borneo (168 species, 19%) (Figure 3). This is followed by Araneidae, with 146 species (17%) in Peninsular Malaysia and 88 species (11%) in Borneo.

It is important to note that some species have been reassigned to other families following taxonomic revision. This includes all species of *Damarchus*, which have been moved to Bemmeridae from Nemesiidae. The species *Pseudanapis parocula* has also been reassigned to Symphytognathidae from Anapidae, while *Crypthotele sundaica* was reassigned to Zodariidae. Some species have also been transferred to other genera; for instance, *Nephila antipodiana* was transferred to *Triconephila* as *Triconephila antipodiana*, and *Chrysso spiniventris* was transferred to *Meotipa* as *Meotipa spiniventris*. The remaining changes in family and genera are noted in Appendix 1, Table 1. Thirteen species were excluded from the main list due to their "*nomen dubium*" status (Appendix 1; Table 2).

Throughout the arachnological research in Malaysia-based literature (from 1841 to the present day), 262 papers based on original material and/or museum collections have been published (Figure 5). The faunistic data were summarised in regional species lists, books, and/or catalogues, with the most significant compilations by Murphy and Murphy (2000) and Norma-Rashid and Li (2009). The first period of spider records in Malaysia lasted for over 130 years, with an average of two published papers per year, except for the year 1890. Spider studies in Malaysia over the years have taken several directions but have been highly skewed towards systematic studies, comprising 218 papers, with many new species and/or genera revisions. Investigations of spiders for habitat distribution were limited to only 36 papers, although these included several protected areas such as the Kuala Selangor Nature Park, Sungai Dusun Wildlife Reserve (Selangor), Tasik Chini Biosphere Reserve, Fraser Hill Wildlife Reserve (Pahang), and Gunung Belumut Forest Reserve (Johor). Six papers discuss the biological aspects of spiders, while three papers investigate the prey preferences of individual spider species.



Note: Sal- Salticidae, Ara- Araneidae, Pho- Pholcidae, Tho- Thomisidae, Oon- Oonopidae, Clu-Clubionidae, The- Theridiidae, Zod- Zodariidae, Tet- Tetragnathidae, Lin- Linyphiidae, Cte- Ctenidae, Cor- Corinnidae, Spa- Sparassidae, Lio- Liocranidae, Lyc- Lycosidae, Ther- Theraphosidae, Lip- Liphistiidae

Figure 4: Species richness of spider families across various regions of Malaysia

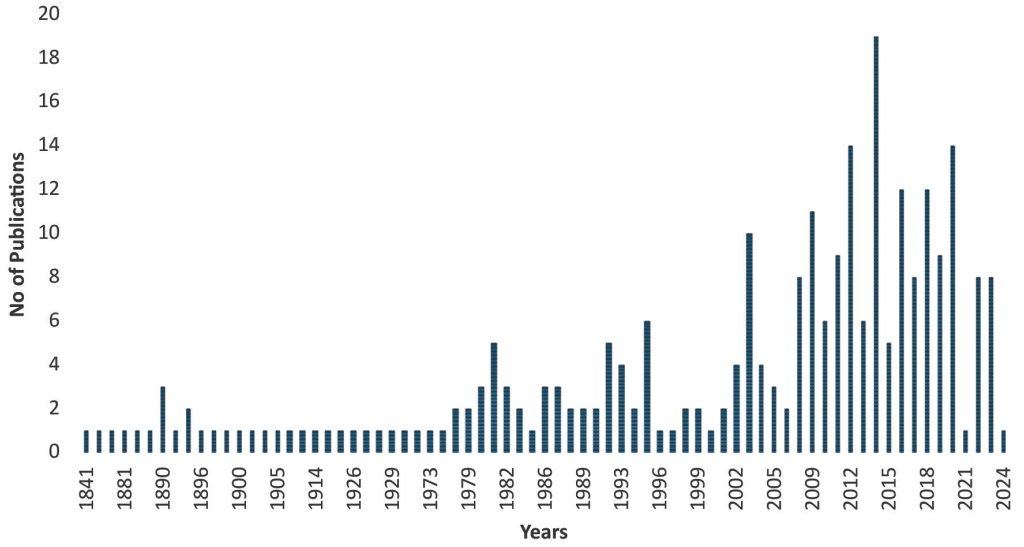


Figure 5: Dynamics of the number of publications concerning spiders of Malaysia during the surveyed period (1841–2023)

Spiders of PPPTR Agroecosystem, Pahang

A total of 1,188 spiders from 11 families, 34 genera, and 65 morphospecies were collected from the agroecosystem in PPPTR, Pahang (Appendix 2; Table 1). Of these, 30 morphospecies (45%) belonged to Araneidae, eight morphospecies (12%) to Salticidae, and seven morphospecies (11%) to Theridiidae. All other families had six or fewer morphospecies represented. Tetragnathidae, on the other hand, were dominant in terms of adult individuals captured, with 490 (45%), followed by Araneidae (423 individuals, 39%) and Oxyopidae (44 individuals, 3%). The most abundant genera were *Leucauge*, *Macracantha*, and *Tylorida*, each with more than 100 individuals. In this study, *Leucauge decorata* is recorded for the first time in Pahang.

The forest had the most abundant spiders (425 individuals), followed by the orchard (227 individuals), oil palm (199 individuals), recreational area (132 individuals), and residential area (97 individuals). The Shannon diversity index provided insight into spider community ecology across habitats. The orchard had the highest Shannon diversity index (H' = 3.29), followed by the residential area (H' = 2.95), oil palm (H' = 2.93), recreational area (H' = 2.57), and finally the forest (H' = 1.90), which had the lowest diversity. The two-way cluster analysis showed that the spider community in the forest strip is altogether different from the rest of the habitat types in the PPPTR agroecosystem, with 0% similarity (Appendix 2; Figure 1). However, the Chi-square test showed no significant difference ($\chi 2 = 75.27$, df = 12, $p > 0.05$) in guild structure between habitats. The capture rates across all sites were dominated by aerial web builders, with a relative abundance of $\geq$ 80%, while sheet builders and hunters comprised less than 15% (Figure 6).

Discussions

Distribution of Spiders in Malaysia Based on Literary Records

The spider fauna of Malaysia is still far from being well studied, despite the long history of research. From a global perspective, the number of spiders found in Malaysia is considerably small compared with the current world checklist, which accounts for 52,654 species classified in

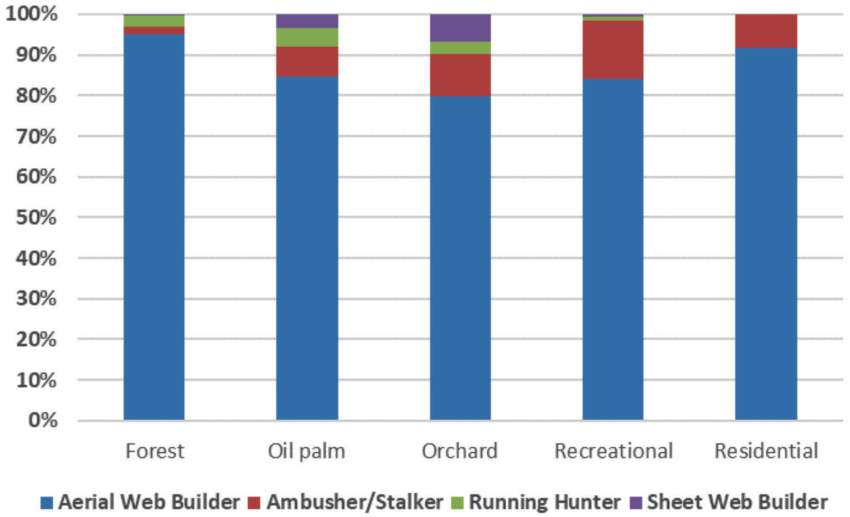


Figure 6: Guild structure of spiders in five different habitat types within in the PPPTR agroecosystem, Pahang

138 families and 4,510 genera (World Spider Catalogue, 2026). The higher number of species in Sabah and Sarawak, in comparison to other states in Peninsular Malaysia, was expected given their large areas, which host the largest number of protected areas in the country, with more than 48% of the land still covered in forest (Scriven *et al*., 2015). At the same time, it is important to note that the various administrative states of Peninsular Malaysia are not thoroughly explored compared to their Borneo counterpart. With climate change and habitat loss occurring at a rapid rate, there is an urgent need for proper documentation of the diversity patterns and preservation of voucher specimens of the Malaysian spider fauna.

The discrepancy in the number of species listed here compared to the previous checklist by Norma-Rashid and Li (2009), Nik Ahmad Irwan *et al.* (2023), and the current Malaysia Biodiversity Information System database (MyBIS, 2024) is due to various taxonomic revisions and new species discovered in the last 15 years. This indicates that the checklist published here is not exhaustive, with many more species yet to be discovered. While many past studies of spiders in Malaysia have focused on systematics and taxonomy, more studies are needed to quantify their distribution across the country. Given the versatility of spiders as generalists, the inventory should not only focus on undisturbed habitats, which have been the target in previous years, but should also incorporate other habitat types, such as agricultural landscapes (Song *et al*., 2020). Furthermore, the focus of spider studies in Malaysia has been on their taxonomy and distribution, with little information on their ecological value. It is time to expedite research into the biology and ecological role of spiders in the Malaysian ecosystem.

Spiders in Agricultural Landscapes of Pusat Penyelidikan Tun Razak, Pahang

Species abundance and richness (1,188 individuals, 65 morphospecies, and 11 families) recorded in this study were low in comparison to other surveys conducted in the country, such as those in forest reserves (Dzulhelmi *et al*., 2019) and botanical gardens (Dzulhelmi & Norma-Rashid, 2014), which were carried out over a longer sampling period. However, the results correspond to those surveys conducted in the Ramsar Site of Tasik Chini (Razak *et al*., 2023) and Fraser Hill Wildlife Reserve (Chooi *et al*., 2014a), following comparable sampling efforts. This suggests that agricultural landscapes in

Malaysia, such as PPPTR in Pahang, have the capacity to support spider diversity comparable to that found in protected areas like Ramsar sites and wildlife reserves. In this study, Araneidae, Salticidae, Theridiidae, and Linyphiidae exhibited high species richness and abundance. These families are also recognised as among the most diverse and widely distributed spider groups globally (World Spider Catalogue, 2026). This finding is consistent with previous studies in Malaysia (Chooi *et al*., 2014b; Sundram & Joseph, 2020). The presence of rich spider communities in agricultural landscapes, especially in orchards and oil palm plantations, indicates a potential for spiders to exert biological control effects on crop pests. Despite this, spiders as general predators may also pose a risk to the conservation of key natural enemies in the agroecosystem (Cotes *et al*., 2018). A thorough study on the influence of spiders on pests and natural enemies in Malaysia would therefore be required to scrutinise their potential as effective biological control agents.

Habitat heterogeneity within the landscape, due to vegetation structure and spatial variation, may drive variations in the spider community (Avila, 2017; Barton *et al*., 2017). As such, multiple guilds of spiders are recorded in the PPPTR, Pahang, with varying distributions. The various tree strata and vegetation types in PPPTR, Pahang, as an agroecosystem with multiple habitat types, likely contribute to diversified spider guilds. Although no specific vegetation or structural data were collected in this study, the heterogeneous habitat conditions may offer a range of microhabitats and foraging opportunities that support different functional groups of spiders. Some species were dominant and highly abundant, which may be attributed to favourable microclimatic conditions influenced by vegetation structure, particularly dense understory shrubs. Such vegetation can provide ample web attachment sites. These conditions are especially beneficial for web-building spiders such as orb-weavers (Araneidae), which rely on stable structural supports for effective foraging (Gómez *et al*., 2016; Dzulhelmi & Norma-Rashid, 2014). This is particularly significant for web-building species found across all habitats in PPPTR, Pahang, such as *Leucauge grata* (Tetragnathidae) and several Araneidae species, including *Argiope dang*, *Araneus* sp.3, and *Gasteracantha kuhli*. These genera, *Leucauge, Araneus, Argiope*, and *Gasteracantha*, are also known for their high diversity in tropical environments and their adaptability to a wide range of habitats (Dzulhelmi *et al*., 2019; Dzulhelmi *et al*., 2022), as evident in the results of this study.

The lack of significant difference in spider guilds across different habitats in the PPPTR, Pahang, was noted, with the dominance of web-weaver spiders across the agricultural landscape. Other past studies have also shown similar results, indicating that the composition of spiders is comparable between different habitats and tree structures (Dzulhelmi *et al*., 2019). However, spider diversity is relatively greater in the orchard, which exhibits notable vegetation complexity. The orchard consists of herbaceous undergrowth and fruit trees such as jackfruit, rambutan, pomelo, and coconut. The fruit trees are at various growth phases with differing densities of fruit stems. This structural complexity positively influences spider diversity in the orchards of PPPTR, Pahang, by providing refuge for spider prey as well as structural support, especially for web-building spiders such as Tetragnathidae, Linyphiidae, Theridiidae, Araneidae, and Agelenidae (Abdullah *et al*., 2019; Dzulhelmi *et al*., 2019; Theron *et al*., 2020).

The diversity of spiders in the forest strip of PPPTR, Pahang, was the lowest, with a prominent presence of *Macracantha hasselti* (previously described as *Gastheracantha hasselti*). This species has been reported to be selective in its prey, showing a high preference for Coleoptera, alongside Diptera, Hymenoptera, and Hemiptera (Michalko *et al*., 2020). The results suggest that the small forest remnant in the PPPTR agroecosystems provides a high abundance of these prey options for *Macracantha hasselti*, although a prey diversity study is needed to confirm this. The forest undergrowth also offers

vertical stratification in the height of the flying insect prey while protecting them from exposure to extreme weather. The presence of *Leucauge decorata* in this study marks the first record in the state of Pahang, where it was previously only found in Penang (Nik Ahmad Irwan *et al*., 2023) and Borneo (Koh & Bay, 2019).

While the aerial web builders were found in large numbers across the PPPTR agroecosystems, sheet web builders, such as Linyphiidae and Agelenidae, were recorded in lower numbers and were absent in residential areas. As the *Agelena* sp. (Agelenidae) builds its web in a horizontal plane and relies on the vibrations of its web to locate prey (Schröer, 2017), constant human activity, particularly in residential areas, may disrupt their ability to find prey. Non-web weavers, such as stalking hunters (*Oxyopes birmanicus*, *Phaecius malayensis*, *Bavia* sp., *Myrmarachne* sp., *Thiania* sp., *Plexippus* sp.) and ambushers (*Phyrnarachne ceylonica*), were harder to detect and capture compared to web-weavers. Nevertheless, *Oxyopes birmanicus* thrives with a relatively higher capture rate than other hunters. Among the primary prey of this spider species are aphids (Upadhyay *et al*., 2020), which are known to be prevalent in agricultural environments such as PPPTR, Pahang (Simon & Peccoud, 2018).

Conclusions

The updated checklist of spiders in Malaysia recorded a total of 1,162 species from 57 families and 438 genera. There is a significant gap in arachnological studies across several states in Peninsular Malaysia, particularly in Perlis, Melaka, Terengganu, and Negeri Sembilan. This highlights the need for further research to document the existing spider fauna in Malaysia, especially in light of climate change and habitat loss. It is also important to investigate the ecological role of spiders in various habitats, including agricultural landscapes. This study identified a diverse composition of spiders with different guild structures across various habitats in the PPPTR, Pahang agroecosystem. Despite its shortcomings, the study in this agroecosystem extends the list of spider species in Pahang (Peninsular Malaysia) by one additional species. The diversity of spiders in agricultural landscapes such as the PPPTR, Pahang, suggests a potential role for spiders as biological control agents against pests, although further studies are needed.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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